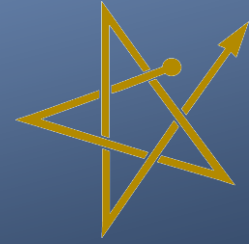


# NPRST



**Navy Personnel Research, Studies, and Technology**

5720 Integrity Drive • Millington, Tennessee 38055-1000 • [www.nprst.navy.mil](http://www.nprst.navy.mil)

research at work

**NPRST-TR-14-3**

**June 2014**

## **Suitability Screening Test for Marine Corps Air Traffic Controllers Phase III: Non-cognitive Test Validation and Cognitive Test Prototype**

**Karen M. Walker, PhD**

**Randy Brou, PhD**

**William L. Farmer, PhD**

***Navy Personnel Research, Studies, and Technology***

Approved for public release; distribution is unlimited.



NPRST-TR-14-3  
June 2014

# **Suitability Screening Test for Marine Corps Air Traffic Controllers Phase III: Non-cognitive Test Validation and Cognitive Test Prototype**

Karen M. Walker, PhD  
Randy Brou, PhD  
William L. Farmer, PhD  
Navy Personnel Research, Studies, and Technology

Reviewed by  
Tanja Blackstone, PhD

Approved and released by  
D. M. Cashbaugh  
Director

Approved for public release; distribution is unlimited.

Navy Personnel Research, Studies, and Technology  
Navy Personnel Command  
5720 Integrity Drive  
Millington, TN 38055-1400  
[www.nprst.navy.mil](http://www.nprst.navy.mil)

<b>REPORT DOCUMENTATION PAGE</b>			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>				
<b>1. REPORT DATE</b> (DD-MM-YYYY)		<b>2. REPORT TYPE</b>		<b>3. DATES COVERED</b> (From-To)
09/06/2014		Technical Report		10/01/2012-09/30/2013
<b>4. TITLE AND SUBTITLE</b>				<b>5a. CONTRACT NUMBER</b>
Suitability Screening Test for Marine Corps Air Traffic Controllers Phase III: Non-cognitive Test validation and Cognitive Test Prototype				<b>5b. GRANT NUMBER</b>
				<b>5c. PROJECT ELEMENT NUMBER</b>
				<b>5d. PROJECT NUMBER</b>
<b>6. AUTHORS</b>				<b>5e. TASK NUMBER</b>
Karen M. Walker, PhD Randy Brou, PhD William L. Farmer, PhD				<b>5f. WORK UNIT NUMBER</b>
<b>7. PERFORMING ORGANIZATIONS NAME(S) AND ADDRESS(ES)</b>				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>
Navy Personnel Research, Studies, & Technology (NPRST/BUPERS-1) Bureau of Naval Personnel 5720 Integrity Drive Millington, TN 38055-1000				NPRST-TR-14-3
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>
Dr. Michael Bailey, Technical Director Operations Analysis Division, MCCDC 3300 Russell Road Quantico, VA 22134				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b>				
Approved for public release; distribution is unlimited.				
<b>13. SUPPLEMENTARY NOTES</b>				
<b>14. ABSTRACT</b>				
A previous technical report detailed the validation process in the Operating Forces (Phase 1) and the ATC Schoolhouse (Phase II); The current Phase III of the project aims to validate the Marine Air Traffic Controller -Suitability Test (MATC-ST) in predicting successful Air Traffic Controllers from the schoolhouse through 7257 Military Occupational Specialty (MOS) qualification and to develop a cognitive test prototype. Hierarchical multiple regression analyses suggest that two variations of the MATC-ST accounts for 17% and 8% of the variance, respectively, in passing overall and 7257 qualification; and provide incremental validity above and beyond the use of the ASVAB score in selection for success in the ATC Military Occupational Specialty (MOS) school and Operating Forces. A suitability profile which can predict success at the ATC MOS school and the Operating Forces greatly increases the efficiency of the personnel pipeline and relieves the burden of unproductive training by providing early detection of Marines who are and are not likely to graduate or perform satisfactorily as ATCs. Further analyses are recommended to validate the cognitive test prototype to determine the approach that will yield the most productive and efficient selection process for the Marine ATC MOS.				
<b>15. SUBJECT TERMS</b>				
ATC cognitive; non-cognitive validation; prototype; suitability screening test; cost-utility analysis; diversity				
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>
UNCLASSIFIED			UNLIMITED	44
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>		<b>19a. NAME OF RESPONSIBLE PERSON</b>
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		Wendy Douglas
				<b>19b. TELEPHONE NUMBER</b>
				(901)874-2218

## Foreword

This effort was funded by the Operations Analysis Division (OAD) under program HQMC AVN APX. The overarching objective of this research effort is to develop and validate a non-cognitive profile of successful US Marine Corps Air Traffic Controllers (ATC) which will assist in the selection and screening process of Marines for ATC duty. This aim was realized by a three-phase process, as discussed in the previous technical reports titled *Suitability Screening Test for Marine Corps Air Traffic Controllers Technical Report and Suitability Screening Test for Marine Corps Air Traffic Controllers Technical Report Phase II (NPRST-TR-13-1 and NPRST-TR-13-2)*. The current report concerns the implementation of Phase III: validation of a noncognitive test and development of a cognitive test prototype to be used for a suitability profile of success in the Marine ATC community. Derived from scores on the Navy Computer Adaptive Personality Scales (NCAPS), the suitability profile was used to predict success using Schoolhouse and Operational Forces performance data. Utilizing this type of non-cognitive profile can greatly increase the efficiency of the Marine Corps ATC personnel pipeline and relieve the burden of unproductive training through detection of Marines who are and are not likely to graduate or perform satisfactorily as ATCs.

The authors wish to thank the funding sponsor, and project officers for their assistance in this project. A number of Marine Corps Air Traffic Control instructors at the ATC-School and training staff within the Operational Air Traffic Control Facilities provided invaluable assistance in the collection of academic/qualification data, and their accessibility greatly enhanced the development of the validation program undertaken in the present study.

D. M. CASHBAUGH  
Director

# Summary Report

## Problem

Entry into military occupational specialty (MOS) training schools requires a minimum score requirement on the Armed Services Vocational Aptitude Battery (ASVAB), a test battery that assesses cognitive abilities through performance in reading, mathematics, general science, as well as basic knowledge about electronics, mechanical systems, and automotive-shop. The ASVAB was designed to increase the effectiveness and efficiency of the selection procedure, and determines that incumbents have the necessary cognitive skills to handle the technical aspects of training and job performance. However, the current Marine Corps Air Traffic Control selection process using the ASVAB has resulted in cognitively proficient applicants, who are, nevertheless, classified as “unsuited” for ATC duty during post-training performance. The inclusion of individuals into the ATC MOS who will ultimately be unfit for this position is inefficient. Building on the first and second phase of the research effort, which developed and validated a Marine Air Traffic Control Suitability Screening Test (MATC-ST) on separate Operational Forces and Schoolhouse performance metrics (Walker, Farmer, & Roberts, 2013), Phase III discusses findings from validity analysis utilizing integrated Marine ATCs Schoolhouse passing data through 7257 qualification data. Phase III also looked at the Federal Aviation Administration’s Air Traffic Scenario Test’s (AT-ST’s) ability to predict Air Traffic Control performance. The ultimate goal is to create a more effective suitability profile, by combining the non-cognitive algorithm with cognitive test results. As such, the objective is to increase the efficiency of the Marine Corps ATC personnel pipeline and reduce the burden of unproductive training by providing early detection of Marines who are and are not likely to perform satisfactorily as ATCs.

## Objective or Purpose

Individuals possess a variety of abilities, preferences, interests, and personal characteristics that should be useful in predicting who will be best suited for different types of military jobs or duties. The overarching objective of this project is to capitalize on these individual differences by developing a non-cognitive and cognitive profile of successful air traffic controllers to be used in the selection procedures for Marine Corps ATC duty. To reach this objective, test scores on measures of non-cognitive traits have been used to develop and validate a profile (MATC-ST) for successful ATC performance in the schoolhouse and operating forces. The current phase of this project seeks to validate a non-cognitive profile in ATC performance in the schoolhouse and Operating Forces along with developing a cognitive test for prediction of successful ATCs performances. Noncognitive validation based on schoolhouse performance and Operational Forces 7257 qualification data seeks to minimize ATC academically-related training failures and Operating Forces revocation to further emphasize the utility of considering non-cognitive traits in conjunction with ASVAB standards when selecting for ATC duty.

## Approach or Method

Using a multifaceted adaptive personality measure, the Navy Computer Adaptive Personality Scales (NCAPS), the authors assessed ATCs in the supporting establishment operating forces (7257 MOS) and Marine ATC students (7251 MOS) on 19 different individual traits. Through both concurrent and predictive validity designs, scores on the NCAPS were correlated with measures of schoolhouse academic performance and Operational Forces 7257 qualification. The results of hierarchical regression analyses indicated that a subset of relevant NCAPS traits were statistically significant predictors of schoolhouse performance and 7257 qualification. Two separate predictive profiles were developed. These profiles were referred to as the Marine Air Traffic Control Suitability Screening Test Passing (MATC-ST Passing and 7257 Qualification) and the Marine Air Traffic Control Suitability Screening Test Qual (MATC-ST 7257 Qualification). NOTE- At the time of this report, the prototype cognitive test was developed, pilot tested, and in its Beta form.

## Findings or Results

The subset of NCAPS traits that demonstrated statistically significant prediction for ATC performance Passing/7257 Qualification and thus were included the Marine Air Traffic Controller - Suitability Screening Test (Passing) algorithms were: *Innovation*, *Social Orientation*, *Perceptiveness*, *Social Orientation*, and *Tolerance for Ambiguity*. Hierarchical multiple regression analyses suggest that the non-cognitive suitability measure adds incremental validity above and beyond the ASVAB score, and accounts for 8.6% of the variance of ATC schoolhouse performance/7257 Qualification ( $R^2=.293$ ,  $\beta = .697$ ,  $t = 3.070$   $p < .000$ ). Given a MATC-ST score, one can predict the expected level of success an individual Marine is likely to exhibit in the ATC schoolhouse and 7257 Qualification in order to make subsequently valid ATC duty selection decisions. NOTE- Data collection was underway for the prototype cognitive ability measures at the time of this report.

## Conclusions

The Marine ATC Suitability Screening Test is a valid algorithm derived from dimensions of NCAPS and has been shown to be predictive of success for Marine ATCs in the Schoolhouse and 7257 Qualification in the Operating Forces. Those with higher suitability scores performed better on knowledge and simulation exams and graduated at a higher rate than those with low suitability scores, as well as qualifying as a 7257 ATC. Data collection and analysis from the ATC schoolhouse graduation to 7257 qualification provided confirmation of the MATC-ST's predictive validity, both for training performance and ATC job performance. Further analysis to derive conservative cut-scores from the combined results of the concurrent and predictive validation from the ATC Schoolhouse/Operating performance is completed. If the noncognitive MATC-ST is to be utilized for selection/classification it is recommended that it be used only in addition to the ASVAB, and implemented at the Military Entrance Processing Station (MEPS) or in the pipeline prior to a Marine ATC MOS designation. Taken together, the two tests are predicted to reduce attrition/revocation and increase the quality of Marines selected for the ATC MOS. MATC-ST implementation can improve the Marine

ATC screening process through better schoolhouse performance, better operating forces performance, less attrition/revocation costs, and increased diversity through fair, valid screening improvements.

# Contents

<b>Introduction.....</b>	<b>1</b>
<b>Background.....</b>	<b>1</b>
<b>Method .....</b>	<b>2</b>
Cognitive Prototype Development .....	3
<b>Data Collection .....</b>	<b>5</b>
ATC Schoolhouse.....	5
MCAS ATC Operational Forces .....	6
Cognitive Prototype Test .....	6
<b>Validity Analysis.....</b>	<b>6</b>
Performance Measures .....	7
<b>Results .....</b>	<b>8</b>
Background and Demographics .....	8
NCAPS Data Summary .....	9
ATC Performance Data Summary .....	10
Marine ATC Suitability Test Score and Validity Analysis .....	10
<b>Other Topics.....</b>	<b>14</b>
Cost-Utility Analysis .....	14
Diversity Discussion .....	14
<b>Recommendations .....</b>	<b>15</b>
<b>Limitations .....</b>	<b>16</b>
<b>Conclusion.....</b>	<b>17</b>
<b>References .....</b>	<b>18</b>
<b>Appendix A: PowerPoint Instructions for Assessments 1-4 .....</b>	<b>A-0</b>

## List of Tables

1. Marine Corps ATC Demographics.....	9
2. ATC Performance Descriptive Statistics .....	10
3. Predictor Test Scores and Passing/Qualification Intercorrelations .....	11
4. ATC Hierarchical Regression Validity Analysis .....	12

## List of Figures

1. Establishing a Conservative Cutscore for MATC-ST Passing .....	13
2. Top 100 GT Score and Diversity.....	15
3. Top 100 GT Score and MATC-ST P and Diversity .....	15



## Introduction

The previous technical reports titled Suitability Screening Test for Marine Corps Air Traffic Controllers Technical Report Phase I & Phase II (Walker, Farmer, & Roberts, 2013a; Walker, Farmer, & Roberts 2013b), gave a complete introduction of the research involved for this study. As a review, the current Air Traffic Control selection process utilized by the US Marine Corps is being reviewed as a result of an unacceptable number of Marine Air Traffic Controllers (ATCs) being classified as “unsuited” for ATC duty as defined by performance and behavioral expectations. The first, most important step in creating a more efficient force is to improve the Air Traffic Controller (ATC) screening/selection process. This research effort focused on developing and validating a non-cognitive and cognitive Air Traffic Controller profile that could be incorporated into a model for their selection. Such a profile would allow the Marine Corps to identify those Marines who are likely to be successful as Air Traffic Controllers, those who need a greater depth of screening, and those who are likely to fail.

During Phase I and II of this research study the focus was on data collection and analysis from Marine ATCs in the operating forces and within the ATC schoolhouse. Phase I results reported significant findings within the Operating Forces, and recommended further predictive validity analysis from the ATC schoolhouse data. Phase II reported significant findings within the ATC schoolhouse, and recommended further predictive validity analysis following ATC schoolhouse Marines to 7257 MOS qualification. This report will discuss Phase III of the study and includes the predictive validity analysis from the ATC schoolhouse and 7257 MOS qualification data.

## Background

Phase I of this study was a concurrent validity study utilizing data collection and analysis from Marine ATCs in the operating forces. The subset of NCAPS traits that demonstrated statistically significant prediction for ATC (operating forces) performance and were included the Marine Air Traffic Controller - Suitability Screening Test (MATC-ST) algorithms were: *Adaptability/Flexibility, Vigilance, Empathy, and Self-Reliance*. Hierarchical regression analyses suggest that the non-cognitive suitability measure adds incremental validity above and beyond the ASVAB score, and accounts for 14% of the variance of ATC job performance ( $R^2=.141$ ,  $\beta=.375$ ,  $t=5.804$ ,  $p<.000$ ). Given this MATC-ST score, one can predict the expected level of success an individual Marine is likely to exhibit on the job and can make subsequently valid selection decisions.

Phase II of this study was a predictive validity study utilizing data collection and analysis from Marine ATCs in the schoolhouse. There were two subsets of NCAPS traits that demonstrated statistically significant prediction for ATC (schoolhouse) performance and were included the Marine Air Traffic Controller - Suitability Screening Test (MATC-ST) algorithms. The MATC-ST (A): *Achievement Motivation, Initiative, Perceptiveness/Depth of Thought, Social Orientation, and Self-Reliance*; and the MATC-ST (B): *Achievement Motivation, Empathy, Perceptiveness/Depth of Thought, Self-Reliance, and Vigilance*. The MATC-ST B was included because it incorporated dimensions that overlap in content to the significant predictors for operational performance developed in Phase I of this research project. Hierarchical regression

analyses suggest that the non-cognitive suitability measure adds incremental validity above and beyond the ASVAB score, and accounts for 29% of the variance of ATC schoolhouse performance ( $R^2=.208$ ,  $\beta = .541$ ,  $t = 4.646$ ,  $p < .000$ ). Given these MATC-ST scores, one can predict the expected level of success an individual Marine is likely to exhibit in the ATC schoolhouse and can make subsequently valid ATC duty selection decisions.

Phase III of this study will discuss findings from validity analysis utilizing Marine ATC schoolhouse/7257 MOS qualification passing and 7257 Qualification data. This effort considers the Armed Services Vocational Aptitude Battery (ASVAB) standard that is established to minimize ATC academically related training failures in conjunction with the suitability screening test to replicate Phase I & II findings. In addition to the noncognitive testing Phase III also included the development and initial pilot testing of the Prototype Marine ATC Cognitive Test.

## Method

The validation approach chosen for this project was a criterion-related strategy. This is traditionally accomplished by obtaining the test scores of job applicants as predictors and then collecting measures of these same individuals' job performance, the criterion (or criteria if more than one type of measure is collected). The predictor test scores are then related statistically to how well individuals perform on the job and, if successful, can be used to identify the most qualified candidates for the position by predicting how individuals with particular test scores will likely perform. This validation methodology is one of three validation strategies presented in the *Uniform Guidelines on Employee Selection Procedures* (1978, EEOC), the *Standards for Educational and Psychological Testing*, and the Society for Industrial/ Organizational Psychology's (SIOP) *Principles for the Validation and Use of Personnel Selection Procedures* (1987).

In personnel selection and classification it is customary to develop measures that predict job performance and/or job tenure. Measures given to job applicants need to assess the knowledge, skills, and abilities necessary for successful performance in a particular job, ideally without producing adverse impact (large mean differences) for racial, ethnic, or gender groups. This study relied on a mix of predictive and concurrent validity designs using NCAPS and Marine ATC performance measures. A concurrent validity design is when the predictor is administered to participants close in time to when the criterion (performance measure) is collected (e.g., on the job). NCAPS was administered in such a concurrent validity design to individuals who are already ATCs.

A predictive validity design is when the predictor is administered long in advance to all applicants who have yet to be selected for the job, and thus represents a more realistic setting in which the instrument will ultimately be used. Additionally, NCAPS was administered in such a predictive validity design to individuals who have not yet been trained as ATCs. The ASVAB (GT Score) was also administered in a predictive validity design.

In order to statistically perform this validation for Phase III, measurements of job performance and NCAPS scores were provided for Marines currently training at the Marine ATC Schoolhouse and those Marines who have qualified as 7257 MOS (both concurrent and predictive data). This included Marine ATCs already attending the ATC

schoolhouse, any new Marine ATC arrivals at the schoolhouse and Marines attaining or revocating from the 7257 MOS.

## **Cognitive Prototype Development**

Phase III required the development of a cognitive ability measures for Marine ATCs similar in nature to those used by the Federal Aviation Administration. As a first step, the authors evaluated the FAA's Air Traffic Scenario Test (AT-ST). Based on this evaluation and a review of the Marine Air Traffic Control Training and Revocations Study (Northrop Grumman Information Systems, 2011), the authors decided to build a battery of tests to measure: 1) working memory capacity, 2) executive control functioning, 3) perceptual speed, 4) multitasking ability, and 5) inductive reasoning ability.

A working memory capacity test was developed because working memory has been linked to performance on complex jobs in a number of domains (e.g., De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012). Further, executive control has been shown to similarly predict complex performance (Kane & Engle, 2003). A perceptual speed test was developed due to the perceived demands on ATCs to track visually displayed data over time in potentially high-density task environments (Ackerman & Cianciolo, 2000). Multitasking ability was likewise targeted due to the perception that ATCs must process information near-simultaneously for multiple aircraft (Hambrick, Oswald, Darowski, Rench, & Brou, 2010). Finally, the role of strategic thinking in performing ATC tasks appeared critical, and previous studies linked inductive reasoning ability with strategy development (Schunn & Reder, 2001).

With these abilities identified, a set of tests was developed that attempted to measure them both in isolation and in tandem. Four tests were developed for the final prototype battery. First, "assessment 1" was developed to test working memory capacity and executive control functioning (as defined by resistance to interference). The test has four phases. During the first phase, users are presented with a set of to-be-remembered stimuli one item at a time. After studying an item, the user must click a button to see the next item. When all items have been presented, the user is prompted to enter the list of stimuli in order. Successful recall results in a longer stimulus set being presented, and users continue to view and recall stimuli until they can no longer successfully recall lists in order. This process is repeated for spatial stimuli, verbal stimuli, and numerical stimuli. The stimuli with which the user is most successful is used in later phases of the test, and the average time spent looking at items within the stimulus set is also used to tailor the later phases of the test to the individual user. During Phase II, the user is presented with processing tasks to complete. Spatial processing tasks involve performing mental rotation to determine if one image is the same as another which has been rotated by 60, 120, 180, 240, or 300 degrees. Verbal processing tasks involve reading a sentence and deciding if it is grammatically and structurally correct or scrambled. Numerical processing tasks involve viewing an equation such as " $21 + 13 - 4 = 29$ " and indicating if the equation is true or false. Users respond to processing tasks until they have correctly responded to five of each type. The average time required to accurately respond to processing items is recorded and used to tailor the test in the remaining phases. Phase III integrates the first two phases by presenting a set of to-be-remembered items between processing tasks (e.g., "2" is presented as a to-be-

remembered item, then a spatial processing task is displayed, next a “4” is presented as a to-be-remembered item, etc.). The to-be-remembered set is composed of the stimulus type identified during Phase I, and each item is presented for the average study time required in Phase I. The processing tasks are chosen randomly from the two stimulus types that are different from the to-be-remembered set’s stimulus type, and a time-limit is imposed equal to two standard deviations above the average processing time identified in Phase II. Like Phase I, successful recollection of a stimulus set results in a longer set being presented, and users stop when they can no longer successfully recall the set in order. In addition, phase three requires that at least two-thirds of the processing tasks be answered correctly within a set before advancement to a longer set is allowed. Phase IV is identical to Phase III except that the processing tasks all come from the stimulus type that matches the to-be-remembered stimulus set’s type. This is believed to result in additional cognitive interference and therefore require more executive control to maintain performance levels. See the Appendix I for further details.

“Assessment two” was developed to test perceptual speed and multitasking ability. The test presents multiple objects consisting of an identifier label and a parameter value which move randomly within a portion of the screen. The parameter value of each object must be compared to a range of values that is acceptable. This range of acceptable values changes over time, requiring users to continuously scan not only the objects, but also the acceptable ranges for the objects’ parameter values. When a user detects that an object’s parameter value falls outside of the acceptable range, he or she must press a button to report the contact. Reporting the contact requires the user to remember and enter the object’s identifier label. Signal-detection theory analysis is used to determine the  $d'$  (pronounced d-prime) sensitivity of users as they scan the screen for out-of-bound values. In addition to the object scanning demands of the task, another section of the screen presents the users with a guidable circle that must be navigated over a set of targets using the arrow keys on the keyboard or screen. Users get points for successfully navigating over the targets. The points acquired for this portion of the task combined with the  $d'$  sensitivity acquired from the first portion of the task provides a measure of user multitasking ability. This portion of the test also serves as a color-blindness indicator, as the targets vary in color in such a way that various types of colorblindness will render users unable to detect the location of the targets against the colored background. Thus, drops in performance for color-blind-sensitive targets compared to color-blind-insensitive targets provides an indication of user color-blindness. See the Appendix I for further details.

“Assessment three” was developed to measure inductive reasoning ability which has been linked to strategy development and analogical reasoning. The first part of the test presents the user with a set of puzzles consisting of an eight by eight grid populated in part with a series of “Xs” and check marks. A set of colored circles begin suspended above the top row of the grid. Without intervention from the user, the circles will move downward towards the bottom of the grid until they impact an “X,” resulting in a failed trial. The user may intervene in the path taken by the circles by placing shapes on the grid that cause the colored circles to begin moving in new directions. Each available shape has a different effect on the circles as a function of their color. This means that to successfully guide the circles to check marks (the goal of the puzzle), users must place the shapes on the grid in such a way that all balls, regardless of color, land on check marks without hitting “Xs.” The second part of the test presents users with a series of

analogies to solve by either selecting a word to complete partial analogy being displayed, or selecting true or false to full analogies being displayed. See the Appendix I for further details.

“Assessment four” was developed to measure each of the skills captured in assessments 1 - 3 in tandem. The test uses a “manufacturing plant” design wherein users must respond to orders for various types of merchandise. The plant consists of five different machines each producing parts of the types of merchandise for sale, as well as a warehouse for storing parts and completed products. Because the machines take different amounts of time to produce their parts, the users must strategically plan how they operate the plant to avoid bottleneck problems. They must also do their best to maintain a small inventory, as storage costs money and eats into the profit they would otherwise make from the sale of merchandise. See the Appendix I for further details.

## **Data Collection**

Data were collected from Marine ATC students (7251 MOS) at the Air Traffic Controller Schoolhouse in Pensacola, Florida and from Operational Forces Marine 7257s in training and those that have qualified during the course of the study. Operational Forces qualification data was collected for nine Air Traffic Control Facilities (ACTFs): Camp Pendleton, Beaufort, Miramar, Cherry Point, New River, Yuma, Futenma, Iwakuni, and Quantico. Data collection consisted of interviews, observations, performance measurements, and NCAPS scores. The interviews and observations were covered thoroughly in Phase I & II technical reports (Walker, Farmer, & Roberts, 2012). This technical report will focus on additional data collection efforts unique to Phase III of the study.

### **ATC Schoolhouse**

The 14-week school consists of three blocks of training that have knowledge based written tests and performance based assessments. Block One training is six weeks long, entirely knowledge based, and concludes with the FAA qualification written exam. Block Two consists of local control, ground control, and flight data performance based assessments. Block Three consists of basic radar, ASR, PAR, and Arrival written tests and performance based assessments.

The schoolhouse requires a 70% or higher grade to pass, however in the operating forces an 80% or higher is required to receive qualifications. ATC officials view ATC school as preliminary and expect that more extensive learning occurs with On-the-Job-Training (OJT), the platform MOS, and other required operating force qualifications to maintain qualified controller status.

- Marine Corps ATC has an ASVAB GT (VE, Verbal + AR, Arithmetic Reasoning + MC, Mechanical Comprehension) score of 110 as a minimum qualifier. A Marine recruit is then designated into Aviation and disseminated between ATC, Weather, and UAV. Instructors also confirmed that this process leads to motivational concerns as to whether Marines selected for ATC School have the motivation to be there.

### ***Schoolhouse Performance Measures***

In order to measure performance at the ATC schoolhouse we collected Grade Point Averages (GPA) for each Marine student at each block of training. Completion of the schoolhouse Blocks 1-3 training resulted in a schoolhouse passing score of 1 and failure at any Block 1-3 resulted in a schoolhouse passing score of 0.

### ***NCAPS at Schoolhouse***

The Navy Computer Adaptive Personality Scales (NCAPS) is a web-based non-cognitive measurement tool consisting of 19 dimensions. NCAPS was administered to incoming and current 7251s.

### **MCAS ATC Operational Forces**

During Phase I & II, after reviewing the existing job analysis information, site visits were conducted to observe controllers from the various MCASs. The primary purpose of these initial site visits was to gain a better understanding of the ATC job, the on-the-job training at each of the MCASs, and to speak with SMEs and supervisors about the training process. Observations were made of the controllers from various radar and tower positions performing their job, and researchers discussed the various components of the job and training process with the controllers, their trainers, and supervisors. In some cases, supervisors identified high and low performers within their teams and described qualities or abilities necessary for high performing ATC Marines.

When a 7251 arrives to a MCAS ATC Facility (ATCF) they endure an indoctrination process that consists of an assignment to an On-the-job Instructor (OJTI), testing, and orientation syllabus. Each MCAS ATCF has an indoctrination process to help a 7251 understand the process to 7257 qualification at that particular ATCF. Each MCAS ATCF also has permanent qualified civilian ATCs as training specialists to ensure continuity.

Phase III data collection from MCAS ATC Operational Forces included time to 7257 qualification and 7257 GPA if available. Successful qualification of 7257 received a score of 1 and unsuccessful completion (failure) or revocation received a score of 0.

### **Cognitive Prototype Test**

Phase III consisted of the development of the cognitive prototype and the initial pilot testing of the four assessment measures. Data collection was conducted for all seven MCAS ATCFs from Phase I & II on all 4 assessments. At the time of this report, data was still being collected and will be analyzed in the near future.

## **Validity Analysis**

Validity, for this study, was defined by the correlation between a predictor of success (such as the ASVAB GT Score, or NCAPS) and an objective performance measure (such as school grades or graduation status, or time to 7257 qualification). The ASVAB (GT Score) has demonstrated validity for predicting job performance, but is most predictive



of academic performance. NCAPS has demonstrated validity for predicting job performance. The two predictors generally do not correlate, but it depends upon the constructs being measured by the specific criterion.

## **Performance Measures**

Job performance is a multifaceted construct that can be measured in a variety of ways (peer ratings, supervisor ratings, customer ratings, output, qualifications, absence of errors, etc.). For Phase III, a variety of proxies for job performance were considered, but the following provided the most significant results.

### ***Schoolhouse performance measures:***

GPA scores for Block One, Block Two, Block Three, and Blocks One through Three (1-3) Cumulative GPA were collected and standardized. ASVAB (GT Scores) were also collected.

### ***MCAS ATC Operational Forces performance measures:***

While some Marines are able to master the position and pass the qualification exams within a few months, others take much longer. Marines who are able to meet qualification at a quicker pace are often considered better performers and more proficient controllers. Therefore, time to qualify may be considered a proxy for job performance, in that these individuals are more naturally suited to the demands of ATC positions, and thus require less time to exhibit proficient performance.

Time to qualify was calculated from training start date to qualification date for 7257, 7252, and 7253/54 and was standardized across ATCFs. Each ATCF provides a unique training opportunity for the Marines stationed there; and as a result, Marines training at different bases are exposed to overlapping, but not quite parallel training opportunities. For example, a station that controls a complex air space that can facilitate a variety of aircraft operations may provide opportunity for Marines to train on a range of real-world scenarios. Meanwhile, Marines at bases with less traffic and less complexity in airspace are not exposed to these challenges as readily or consistently. This variability in exposure is likely to facilitate training on some bases, and allow Marines to more quickly qualify on their positions. Given this set of circumstances, standardization was necessary for time to qualify across ATCFs, such that those who quickly qualify at their respective stations will be acknowledged as high performing trainees.

There was considerable variability among each ATCF; therefore a standardization technique was used to place performance scores by ATCF on a common scale. For example, a high performer at Cherry Point ATCF may qualify in four months whereas a high performer at Yuma ATCF may qualify in six months. In this case, standardized scores per ATCF will recognize high performers across various units and not differentiate them when site factors, not personnel attributes or ability, account for the time differentials.

Marines attaining the 7257 qualification received a score of 1 and those who did not attain the 7257 MOS due to poor performance received a score of 0. Medical drops and

Non-Academic drops were not included in analysis. Qualification test scores (written exam and performance exam) were collected and averaged for a GPA for 7257. The GPAs were also standardized by ATCF.

## Results

The resulting data from the ATC schoolhouse and Operational forces were cleaned and subjected to various analyses including validity analysis. This section describes the data obtained and analyses with the results reported up front. Validity analysis determined:

- NCAPS scores are a valid predictor of success for Marine Air Traffic Controllers passing the schoolhouse and attaining 7257 qualification. Success in the schoolhouse is determined by graduation from ATC School. Success in the Operating Forces is determined by performance at a Marine ATCF and 7257 qualification.
- ASVAB GT Scores correlated significantly with *Passing* for the schoolhouse as did NCAPS measures.
- Regression analyses clearly indicate that non-cognitive measures, especially those assessed with the Marine Air Traffic Control Suitability Test Passing and Qual (MATC-ST Passing and Qual): add incremental validity above the ASVAB GT Score.

## Background and Demographics

This section describes the sample of participants who took part in the study, as well as the characteristics of the performance measures collected from those participants. Table 1 presents background and demographic information for 405 Marine Corps ATC (7251/7257) participants. The majority of the sample was male (92.6%), White (67%), with less than 4 years of service (93%). Most of the sample was Private First Class (PFC; E2 paygrade), (72.8%).



**Table 1**  
**Marine Corps ATC Demographics**

		Frequency	Percent
Gender	Male	375	92.6
	Female	30	7.4
Ethnicity	White	271	66.9
	Hispanic	62	15.3
	Black	37	9.1
	Asian or Pacific Islander	15	3.7
	American Indian	5	1.2
	Other	15	3.8
Rank	E1 (PVT)	42	10.4
	E2 (PFC)	295	72.8
	E3 (LCPL)	19	4.7
	E4 (CPL)	28	6.9
	E5 (SGT)	21	5.2
YoS	<4	379	93.6
	5-10	26	6.3

### NCAPS Data Summary

At the time of this report, complete data was obtained from the NCAPS measure for 405 Marine Corps ATC (7251/7257 MOS) participants.

NCAPS is a computerized adaptive personality measure consisting of 19 components, four of which were related to attributes relevant to the current research effort. For each NCAPS component, the data consist of a trait level value that describes the participants standing on the construct being measured, and a PSD or posterior standard deviation, which is an index of algorithm convergence. A theta value is defined as an individual's standing on a construct being measured using adaptive testing and item response theory, where items are presented to individuals based on their responses to prior items. This process continues until the algorithm closes in on that individual's standing on the construct, which is represented by the value of theta.

There were seven relevant NCAPS dimensions for the ATC Passing and 7257 Qualification. These NCAPS dimensions were used to develop the algorithms for the Marine Air Traffic Control Suitability (MATC-ST). There are two relevant algorithms for the ATC suitable performance. These will be referred to as the Marine Air Traffic Control Suitability Test Passing (MATC-ST P) and the Marine Air Traffic Control Suitability Test Qualification (MATC-ST Q). The Marine Air Traffic Control Suitability Test Passing dimensions were: Tolerance for Ambiguity, Innovation, Perceptiveness/Depth of thought, and Social Orientation. The Marine Air Traffic

Control Suitability Test Qualification dimensions were: Adaptability/Flexibility, Positive Self-Concept, and Vigilance. The MATC-ST Q has a much smaller sample size as a result of the 9-month MARADMIN requirement for 7257 qualification. The degree of relevance, or relatedness (validity) was derived through regression analyses, which identified these dimensions (or traits) as statistically significant predictors of ATC performance at the Schoolhouse and 7257 qualification.

## ATC Performance Data Summary

The ATC performance data summary in Table 2 includes the minimums, maximums, means, modes, and standard deviations of GT Score, Passing, and 7257 Qualification. GT Scores were collected for 404 ATC Marines, with a minimum GT Score of 105, a maximum GT Score of 146, a mean GT Score of 118.45, and the standard deviation for GT Score was 7.559.

Passing was collected for 321 ATC Marines, with 212 passing and 109 failures/revocations. Passing represented 66.0% and the failure percentage was 34%. Qualification was collected for 114 ATC Marines, with 100 qualified 7257s and 14 revocations. Qualification represented 87.6% and revocation represented 12.4%. (The Qualification sample size is smaller as a result of the 9-month MARADMIN requirement for 7257 qualification).

**Table 2**  
**ATC Performance Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
GT Score	404	105	146	118.45	7.559
Passing *	321	34.0%*	66.0%*	N/A	N/A
Qualification**	114	12.4%*	87.6%*	N/A	N/A

\*Passing percentages include passing and failures/revocations.

\*\*Qualification percentages include 7257 qualification and revocations.

## Marine ATC Suitability Test Score and Validity Analysis

The Marine ATC Suitability Test Passing (MATC-ST P) and MATC-ST Qualification (MATC-ST Q) score for the ATC population is calculated from dimensions of NCAPS that were submitted in regression analysis with the ATC schoolhouse Block 1-3 completion (Passing) and 7257 Qualification as the performance criterion. This section describes the correlation and regression analyses.

Table 2.2 presents the intercorrelations of the predictor test scores, (MATC-ST P), (MATC-ST Q), ASVAB GT and Passing/Qualification.

**Table 3**  
**Predictor Test Scores and Passing/Qualification Intercorrelations**

	MATC-ST P	MATC-ST Q	GT Score	Passing	7257 Qual
MATC-ST P	1				
MATC-ST Q	.142**	1			
GT Score	.173**	.113*	1		
Passing	.288**	.053**	.296**	1	
7257 Qualification	.178	.416**	.045	1.00**	.1

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

Note: The Qualification sample size is smaller as a result of the 9-month MARADMIN requirement for 7257 qualification

Table 3 shows the intercorrelations between GT Score, the MATC-ST P and MATC-ST Q, and the Marine ATC performance metrics. Predictor test scores were significantly correlated with one another, Suitability P and Q algorithms, and with GT Score at the  $p < .01$  level; with exception for correlations with 7257 Qualification with MATC-ST P and GT Score). GT Score was also significantly correlated to MATC-ST P and MATC-ST Q at the  $p < .05$  and  $p < .01$  levels respectively. For completeness, the data were used in a hierarchical regression.

Through hierarchical regression, the prediction of the MATC-ST P and Q score on performance outcomes may be isolated and compared to the prediction of other factors, such as the ASVAB GT score, as well as the prediction of composites of multiple factors at once. This technique uses comparisons of successive regression models and determines the significance that each one has above and beyond the others. Three models were tested and compared: (1) the ASVAB GT scores' prediction of Passing/7257 Qualification, (2) the MATC- Suitability Test scores' prediction of Passing/7257 Qualification, and (3) regression weighted composite scores' (made up of ASVAB GT and MATC-ST) of Passing/7257 Qualification.

The Marines currently use the ASVAB as a selection screening tool to gain access to the ATC School; therefore, GT Score was the first variable entered (model 1), followed by the MATC-ST P score (model 2), and the resulting composite (model 3). The same model process was conducted for MATC-ST Q score (model 2a) and the resulting composite (model 3a). Results of the regression analysis are presented in Table 4 (weights are standardized beta ( $\beta$ ) weights).

**Table 4**  
**ATC Hierarchical Regression Validity Analysis**

Measure	Standardized Regression Coefficient	R <sup>2</sup>	ΔR <sup>2</sup>	F	ΔF	t
Model 1: GT Score	.296	.087	--	30.449*	--	5.518*
Model 2: MATC-ST P	.293	.086	--	7.401*	--	3.070*
Model 3: GT Score & MATC-ST P	.296 .385	.149	.085 .143	30.449*	30.449 22.759	5.518* 4.771*
Model 2a: MATC-ST Q	.416	.173	--	23.266*	--	4.823*
Model 3a: GT Score & MATC-ST Q	.045 .416	.158	.002 .171	22.807*	.222 11.536	.471 4.776*

a. Dependent Variable: Passing/7257 Qualification; \*Statistically significant at the  $p < .001$  probability level.

The Table 4 results showed that, as expected from the results in table 2.2, GT Score alone (Model 1) predicts Passing Schoolhouse performance at a statistically significant level (Model 1;  $\beta = .296$ ,  $R^2 = .087$ ,  $F = 30.449$ ,  $t = 5.518$ ,  $p < .000$ ), accounting for 8.7% of the variance in performance. When the MATC-ST P was added into the next step (Step 2) of the hierarchical regression analysis, the results were also statistically significant (Model 2;  $\beta = .293$ ,  $R^2 = .086$ ,  $F = 7.401$ ,  $t = 3.070$ ,  $p < .000$ ). Together, the MATC-ST P and GT Score account for 14.9% of the variance in performance.

A composite of the two variables entered in the third model (Step 3) improved the prediction over MATC-ST P alone (Model 3;  $\beta = .385$ ,  $R^2 = .149$ ,  $\Delta R^2 = .143$ ,  $F = 30.449$ ,  $\Delta F^2 = 22.759$ ,  $t = 4.771$ ,  $p < .000$ ). The composite of GT Score and the Suitability Passing test score ( $R^2 = .149$ ), suggests that the predictive validity of the components work together additively to increase the validity of the prediction with regard to Passing performance.

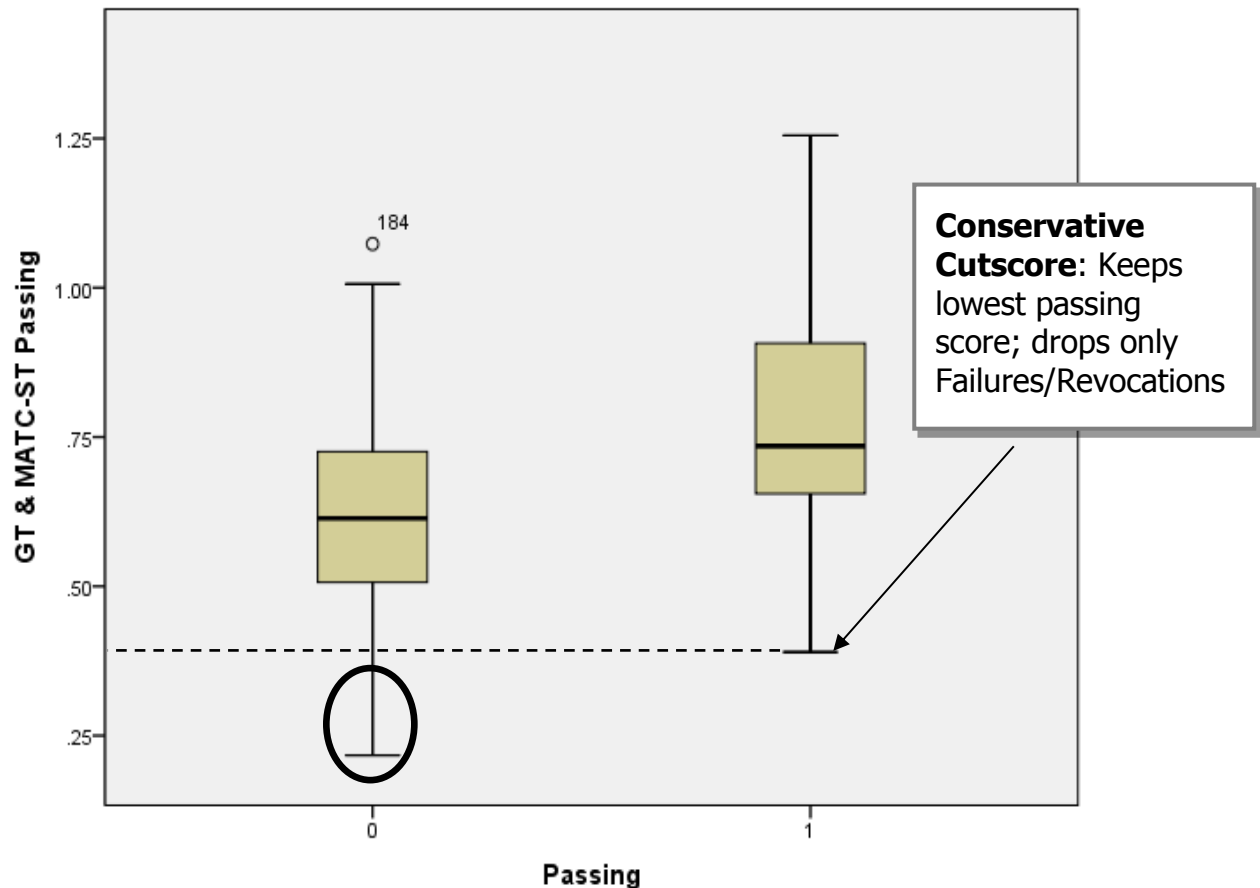
In Table 4 results showed that, the MATC-ST Q predicts 7257 Qualification performance at a statistically significant level (Model 2a;  $\beta = .416$ ,  $R^2 = .173$ ,  $F = 23.266$ ,  $t = 4.823$ ,  $p < .000$ ), accounting for 17.3% of the variance in performance. When the GT Score and MATC-ST Q were hierarchically regressed onto 7257 Qualification performance, the results were also statistically significant (Model 3a;  $\beta = .416$ ,  $R^2 = .158$ ,  $\Delta R^2 = .171$ ,  $F = 22.807$ ,  $\Delta F^2 = 11.536$ ,  $t = 4.776$ ,  $p < .000$ ).

Together, the MATC-ST Q and GT Score account for 15.8% of the variance in 7257 Qualification performance. The composite of GT Score and the MATC-ST Q score ( $R^2 = .158$ ), suggests that the predictive validity of the components work together additively to increase the validity of the prediction with regard to 7257 Qualification performance.

Figure 1 is a box plot graph illustrating the recommendation of establishing a conservative cutscore for the MATC-ST P that utilizes the combined GT and MATC-Suitability Test P as the predictor ( $R^2 = .149$ ).  $R^2$  (variance overlap) is the proportion of the Passing score that is accounted for by the predictor. The square root of this value is

the correlation. The graph also indicates setting a conservative cutscore will keep the lowest passing score and drop only failures/revocations.

**Figure 1. Establishing a Conservative Cutscore for MATC-ST Passing**



\*Note: n=321 Marine ATCs

Together, GT Score and MATC- Suitability Screening Test Passing score account for 14.9% of the variance in Passing performance; and GT Score and MATC- Suitability Screening Test 7257 Qualification score account for 15.8% of the variance in 7257 Qualification performance. The “variance accounted for” metric interpretation of a correlation provides meaningful insights into the value of a selection & classification instrument. That is, predictor test developers strive for 100% performance variability accounted for by the predictor (a correlation of 1.0). However, to set a cutscore for an operational selection standard, the correlation coefficient (validity coefficient) is required.

The MATC-ST P and Q have been shown to be predictive of success for Marine ATCs in Passing and 7257 Qualification. Success is determined by passing the MOS Schoolhouse and/or completing 7257 qualification, therefore the higher the MATC-ST score the higher the probability to complete ATC School and 7257 qualification. The expectation is that the relationship will hold up for future ATC Marines at the schoolhouse and setting a conservative cutscore is recommended for noncognitive MATC-ST P score at this time. A near term goal would be to evaluate the positive effects

of this operational cutscore for cost savings and increased ATC operational performance.

## **Other Topics**

### **Cost-Utility Analysis**

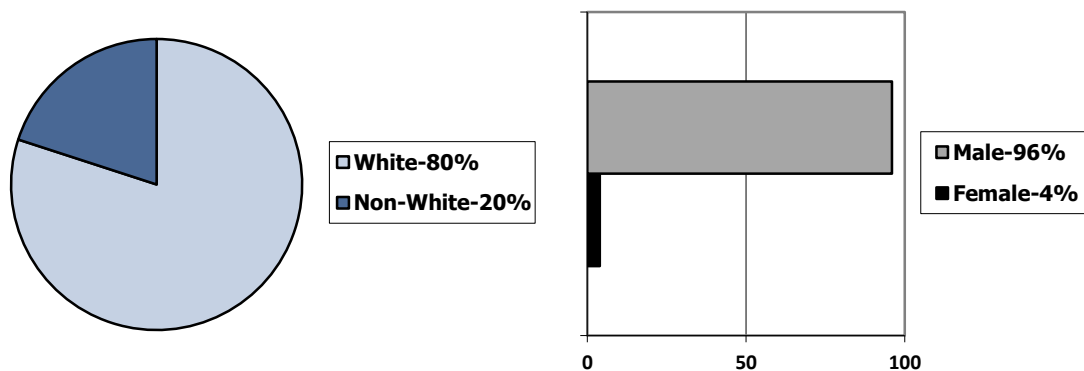
An additional topic of interest is the positive impact that the MATC-ST had on predicted cost savings and diversity. From the ATC schoolhouse passing sample (n=321), we estimated the cost of failure/revocation before and after the implementation of the MATC-ST. Total cost per ATC Marine was estimated at \$28,671. This cost was estimated from three costs: 9 month E-3 Salary + .33 benefits= \$21,391; Schoolhouse cost per student \$2280; and Permanent Change of Station (PCS) cost= \$5000. The “.33 benefits” is an estimated fringe benefit, which is the cost that the employer pays for health, dental, life, social security tax, etc. (This figure may differ for the military but is a realistic and comparable cost estimate for employers.). These figures are conservative cost estimates and do not take into account any implicit costs such as facilities, lost wages, overtime, instructor salary, etc. Using the current selection measures it is predicted that the Marine ATC MOS has a failure cost of \$3.1 million considering its current 34% failure percentage. With the implementation of the MATC-ST passing it is predicted that the Marine ATC MOS will reduce its failure percentage to 27.1% resulting in a savings of at least \$635K per year. As a conservative estimate for every 1% drop in the failure percentage the MATC-ST will have a savings of over \$92K.

### **Diversity Discussion**

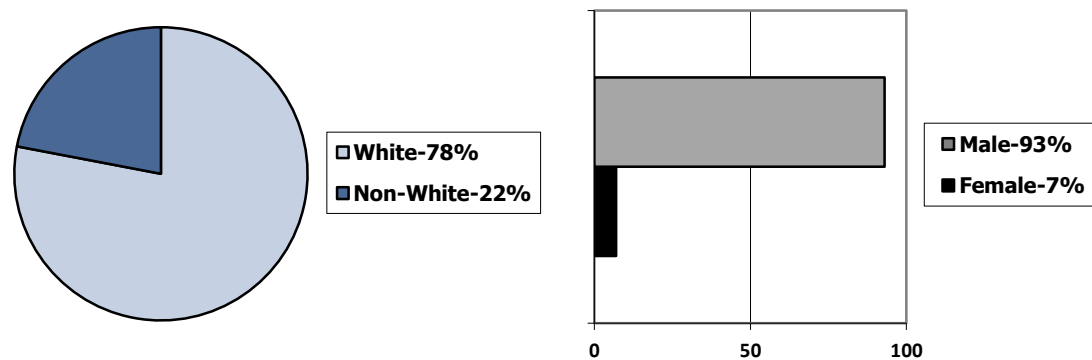
From the ATC schoolhouse sample (n=405), we sorted GT Scores from highest to lowest and we selected the top 100 GT scorers. The diversity picture is illustrated in Figure 2 and annotated here: White (80%) and Non-white (20%); Male (96%) and Female (4%).

We then sorted the GT & MATC-ST P scores highest to lowest and we selected the top 100 scorers. The diversity picture is illustrated in Figure 3 and annotated here: White (78%) and Non-white (22%); Male (93%) and Female (7%).

**Figure 2. Top 100 GT Score and Diversity**



**Figure 3. Top 100 GT Score & MATC-ST P and Diversity**



The addition of the MATC-ST can improve the ATC screening process through fair, valid screening improvements that not only predict high performance in the operating forces (Walker, Farmer, & Roberts, 2012) and schoolhouse (Walker, Farmer, & Roberts, 2013), but also increase diversity within the Air Traffic Control field.

## Recommendations

At the time of this report the Marine ATC Suitability Screening Test (MATC-ST) is shown to be predictive of success for Marine ATCs in the operating forces (Phase I results) and the ATC schoolhouse (Phase II results). The Marine ATC Suitability Test (MATC-ST) score is a valid algorithm derived from dimensions of NCAPS. It is recommended to set a conservative cutscore for the noncognitive MATC-ST P score at this time to be used for selection prior to MOS selection for Marine ATCs.

Further data collection and analysis from Phase III cognitive beta testing is recommended to provide confirmation of the additional cognitive test's predictive validity, both for training performance and ATC job performance. It is best practice to combine concurrent validity with predictive validity from the ATC Schoolhouse in order to recommend any conservative cutscores and/or implementation into the Marine Corps Air Traffic Control selection and classification process. (This recommendation has been submitted as a Phase III proposal Addendum 2 and is pending at the time of this report).

As of the date of this report Phase I, Phase II and Phase III results were briefed to project officers. It is important to note that Phase I results were from operating forces and Phase II results were from the schoolhouse. Phase III results recommended the best overall MATC-ST algorithm for predicting Marine ATC performance as defined by project officers (e.g. time to qualify, GPA, behaviorally anchored rating scales, etc.).

If the MATC-ST is to be utilized for selection/classification it is recommended that it be used only in addition to the ASVAB (GT) in a hurdle approach, and implemented at the Military Entrance Processing Station (MEPS) or similar establishment prior to a Marine ATC MOS designation/assignment. This will reduce attrition/training costs, and increase the quality of Marines selected for the ATC MOS.

## Limitations

The length of this study was approximately one year. A hindering factor was allowing enough time for performance measures to be collected (schoolhouse graduation and 7257 qualification based on 9 month MARADMIN requirement). The timing did not have an impact on results other than delaying Phase III analysis in order to allow enough time for performance measures to be collected. Although, NCAPS allowed for maximum participation among Marine Air Traffic Controllers in the schoolhouse because it was web enabled and administered at the beginning of training; the performance data collection took much more time to collect. It was necessary for an adequate amount of time to pass to collect such data from the ATC schoolhouse and Operational Forces.

Another limitation at the time of this report is that the ATC Cognitive prototype data and analysis is not complete for the Operational Forces. The Cognitive prototype was developed and demonstrated to all sponsors and administrators, however actual beta testing began in September 2013. Further analysis will need to be performed, as recommended for Phase III Addendum 2 to include ATC schoolhouse participants and to allow for a larger sample size and any range restriction. An additional report would need to be produced at the time of Phase III Addendum 2 data analysis completion for any cognitive test implementation recommendations.

The authors tried to get a sample that was most representative of the population; however it is an understandable limitation that the sample may not be as representative as the population.



## Conclusion

This report further concluded findings from the ATC operating forces (Phase I) and schoolhouse (Phase II) study that NCAPS dimensions calculated specifically for the Marine Air Traffic Control community can predict success in training as well as on the job. Phase III of the Marine Air Traffic Control Suitability Screening Test (MATC-ST) project focused on passing performance and 7257 Qualification to allow for a larger sample size and any range restriction, predicting passing and 7257 Qualification in ATC schoolhouse graduates (7251). Recommendations were made for implementation of an operational conservative cutscore for MATC-ST Passing. The expectation is that the relationship will hold up for future ATC Marines, and that a near term goal would be to evaluate the positive effects of such cutscore on training cost savings and operational performance. Phase III Addendum 2 also recommends the continued validation of the MATC-ST cognitive prototype addition.

MATC-ST implementation can improve the Marine ATC screening process through better schoolhouse performance, better operating forces performance, and increased diversity through fair, valid screening improvements. As with any test, it is important to continue to validate these tools considering changes in curriculum and additions of simulation based training in order to see if the ASVAB composites and MATC-ST cutscores are adequate for producing a job ready Marine.

## References

- Ackerman, P. L., & Cianciolo, A. T. (2000). Cognitive, perceptual-speed, and psychomotor determinants of individual differences during skill acquisition. *Journal of Experimental Psychology: Applied*, 6(4), 259.
- De Dreu, C. K., Nijstad, B. A., Baas, M., Wolsink, I., & Roskes, M. (2012). Working memory benefits creative insight, musical improvisation, and original ideation through maintained task-focused attention. *Personality and Social Psychology Bulletin*, 38(5), 656-669.
- Equal Employment Opportunity Commission, Civil Service Commission, Department of Labor, & Department of Justice. (1978). Uniform guidelines on employee selection procedures. Federal Register, 43 (166) 38290-38315.
- Hambrick, D. Z., Oswald, F. L., Darowski, E. S., Rench, T. A., & Brou, R. (2010). Predictors of multitasking performance in a synthetic work paradigm. *Applied Cognitive Psychology*, 24(8), 1149-1167.
- Kane, M. J., & Engle, R. W. (2003). Working-memory capacity and the control of attention: the contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of experimental psychology: General*, 132(1), 47.
- McBride, T.M. (2012). *Study of personnel attrition and revocation within U.S. Marine Corps Air Traffic Control specialties*. (Unpublished master's thesis). Embry-Riddle Aeronautical University, Daytona Beach FL.
- Northrop Grumman Information Systems. (27 Sep 2011). Marine Corps Studies Program Support: Marine Air Traffic Control Training and Revocations Study.
- Schunn, C. D., & Reder, L. M. (2001). Another source of individual differences: strategy adaptivity to changing rates of success. *Journal of experimental psychology: General*, 130(1), 59.
- Society for Industrial and Organizational Psychology (1987). *Principles for the validation and use of personnel selection procedures*. (3rd ed). College Park, MD: Author.
- Walker, K.M., Farmer, W.L., and Roberts, R.C. (2012). *Suitability Screening Test for Marine Corps Air Traffic Controllers Technical Report* (Technical Report No. 13-1). Millington, TN: Navy Personnel Research Studies and Technology.
- Walker, K.M., Farmer, W.L., and Roberts, R.C. (2013). *Suitability Screening Test for Marine Corps Air Traffic Controllers Technical Report Phase II* (Technical Report No. 13-2). Millington, TN: Navy Personnel Research Studies and Technology.

## **Appendix A:**

### **PowerPoint Instructions for Assessments 1-4**

# Assessment 1 Instructions

Dr. Karen Walker  
NPRST



## Assessment 1 Tasks

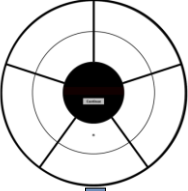
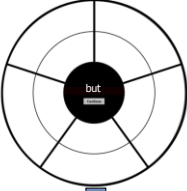
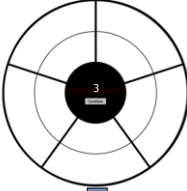
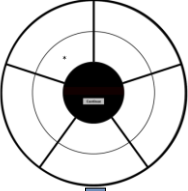
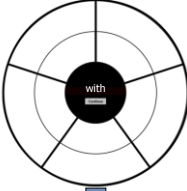
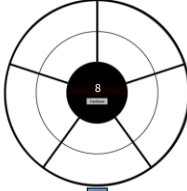
- Assessment 1 requires
  - memorizing a sequence of spatial positions, words, or numbers
  - while responding to various processing tasks



NPRST

## Sequences To Be Memorized

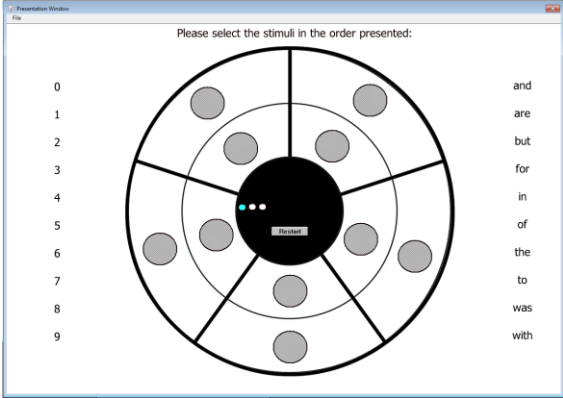
First you will see one of three types of sequences (made up of spatial, verbal, or numeric stimuli) that you must commit to memory

Spatial	Verbal	Numeric
		
		

NPRST

## Response Grid

- After you have seen a full sequence, you will respond by entering the stimuli in the order in which they appeared





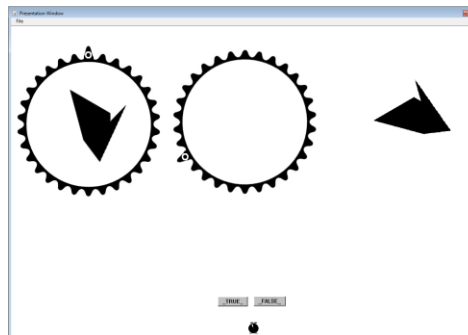
## Processing Tasks

- There are also three types of “processing tasks” that you must respond to during the assessment
  - Rotations
  - Sentences
  - Equations
- These tasks are timed and you need to answer at least 75% of them correctly during each sequence



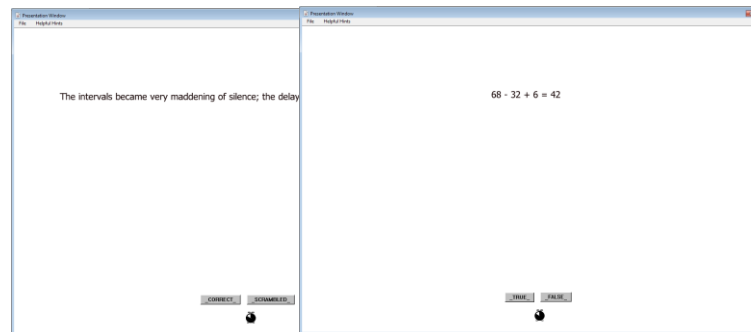
## Processing Task Details (Rotations)

- For the rotation processing task, you must decide if the figure on the right represents what the figure on the left would look like if the “frame” on the left were rotated to match the “frame” in the middle.
- In this case, the correct response would be “FALSE”



## Processing Task Details (Sentences and Equations)

- For the sentence and equation processing tasks, you must decide if the:
  - sentence word order is correct or scrambled
  - equation is true or false



## Task Order

- Now that you have seen the types of tasks, here is the order you can expect during the assessment:
  - 1) Spatial sequences
  - 2) Verbal sequences
  - 3) Numeric sequences
  - 4) Spatial processing (rotations)
  - 5) Verbal processing (sentences)
  - 6) Numeric processing (equations)
  - 7) Sequences with a processing task between each item
- Remember, you must try your best to both remember the sequences and solve the processing tasks correctly for each set

## Thank You and Good Luck

- Click any key to enter the assessment

NPRST



## Assessment 2 Instructions

Dr. Karen Walker  
NPRST

NPRST  
research at work





## Assessment 2 Tasks

- Assessment 2 requires
  - scanning a set of objects (called "Contacts") continuously
  - while maneuvering another object over targets

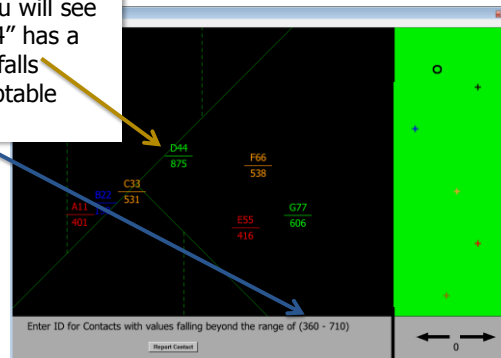
NPRST



## Contact Scanning

- The left side of the screen below shows a set of contacts that will be moving around the screen during the assessment.
- You must constantly scan these contacts to make sure the value shown below the line for each contact falls within the acceptable range of values.

In this image, you will see that contact "D44" has a value (875) that falls outside the acceptable range (360-710).



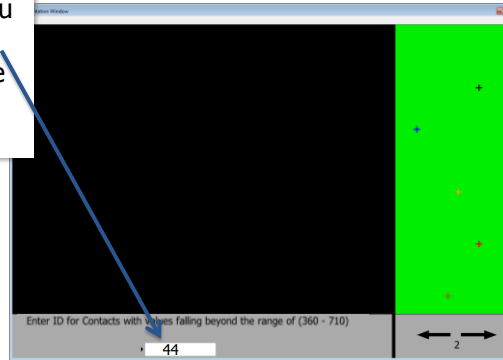
NPRST



## Contact Reporting

- When you spot a contact that is outside of the acceptable range, you will click the button "Report Contact"
- The screen will change as shown below, and you must enter the ID number of the contact

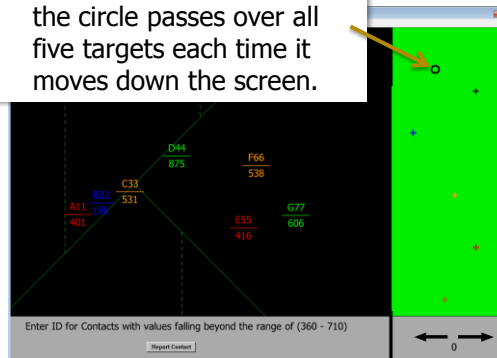
In this case, you would enter 44 (leaving out the first letter of "D44")



## Maneuvering Task

- On the right side of the screen, you will need to maneuver an object (the black circle) over targets (the "+"s").
- You can control the object either by clicking on the left and right arrows on the screen, or by pressing the left and right arrow keys on your keyboard.
- **Note that both scanning and maneuvering tasks must be performed at the same time throughout the assessment.**

The goal is to make sure the circle passes over all five targets each time it moves down the screen.



## Thank You and Good Luck

- Click any key to enter the assessment

NPRST



## Assessment 3 Instructions

Dr. Karen Walker  
NPRST

NPRST  
research at work



## Assessment 3 Tasks

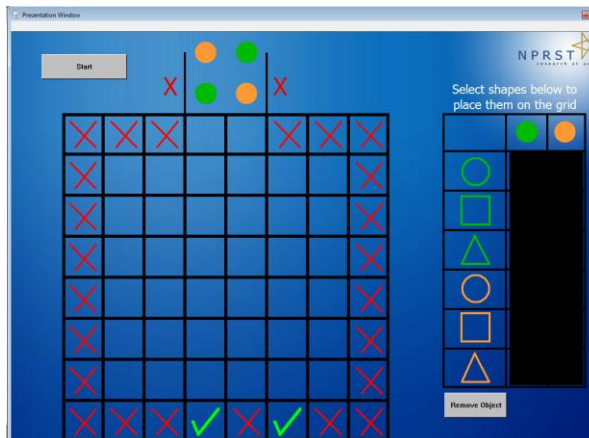
- Assessment 3 requires
  - directing orange and green circles towards designated goals ("checks") while avoiding any circles touching obstacles ("X's")
  - solving analogies

NPRST



## Initial Arrangement

- Each "puzzle" in the assessment will begin with four circles (two green and two orange) sitting above the top of the 8x8 grid.
- You must place the shapes at your disposal on the grid in such a way that all four circles will end on a goal.
- You have 20 minutes to solve as many puzzles as possible.



NPRST

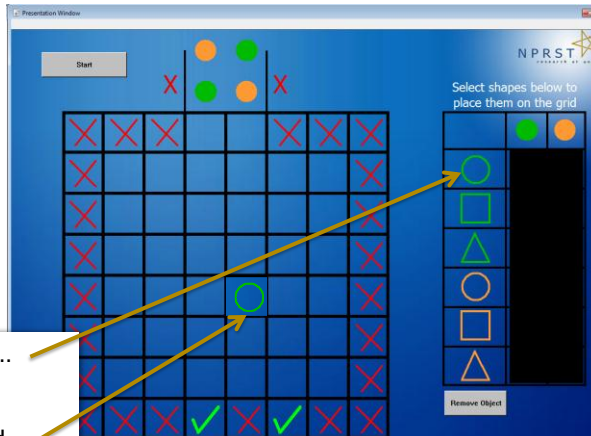


## Adding /Removing Shapes

- To add a shape to the grid, click on the shape you want to use, then click on the spot in the grid you want it to appear.
- Each shape will affect orange and green circles differently.
- To remove a shape, click the "Remove Object" button, then click on the shape you want to remove

First, click the shape...

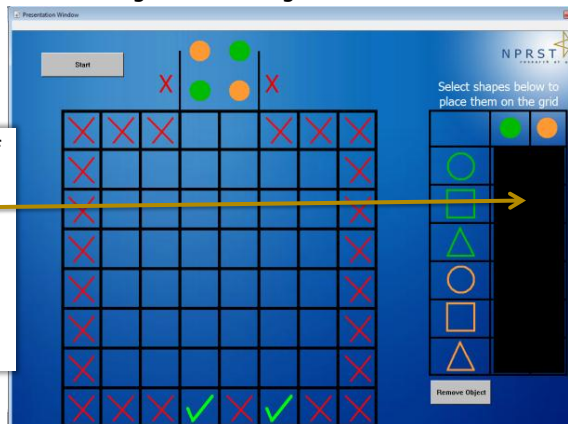
Then click on the grid...



## The Effect of Shapes

- When you press "Start," each of the four circles will start moving toward the bottom of the grid
- When a circle encounters a shape, its direction of movement will change to match the direction shown in the legend on the right of the screen.

In the assessment, a set of directional arrows will be shown here. These arrows will indicate how green or orange circles will react when they encounter each shape placed on the grid.





## Analogies

- After 20 minutes working on the puzzles, you will have five minutes to solve a series of analogies.
- You will see statements such as:
  - PENCIL is to PAPER as BRUSH is to \_\_\_\_\_
    - » In this case you would choose the best of four options to complete the analogy
  - ROAD is to CAR as WATER is to JET
    - » In this case you would choose either TRUE or FALSE depending on the accuracy of the analogy



## Thank You and Good Luck

- Click any key to enter the assessment

# Assessment 4 Instructions

Dr. Karen Walker  
NPRST



## Assessment 4 Tasks

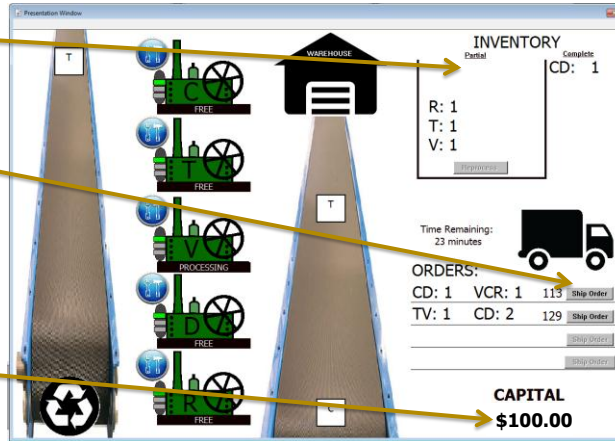
- Assessment 4 requires
  - filling orders for equipment by running a “manufacturing” system

NPRST



## Orders

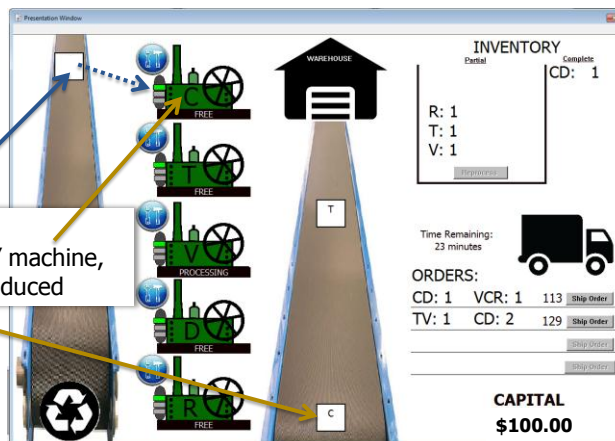
- Orders are shown on the bottom right of the screen. Each order specifies an amount of one or two types of items to be produced in a certain amount of time.
- When your inventory contains enough of each type of item to fill an order, you can click the "Ship Order" button next to the order to fill it.
- Payment for the order is given immediately, and is reflected in your CAPITAL displayed below the orders.



## Manufacturing

- In order to manufacture items, you must process raw materials through a series of machines.
- Dragging and dropping a box into a machine will produce a box with the letter of that machine on it.

If an empty box is dropped into the "C" machine, a "C" box will be produced

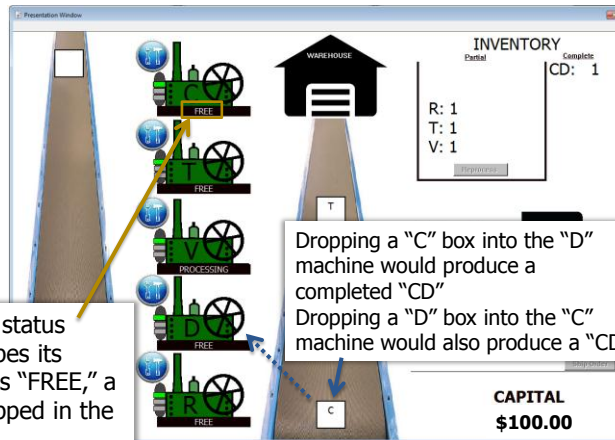




## Manufacturing (Continued)

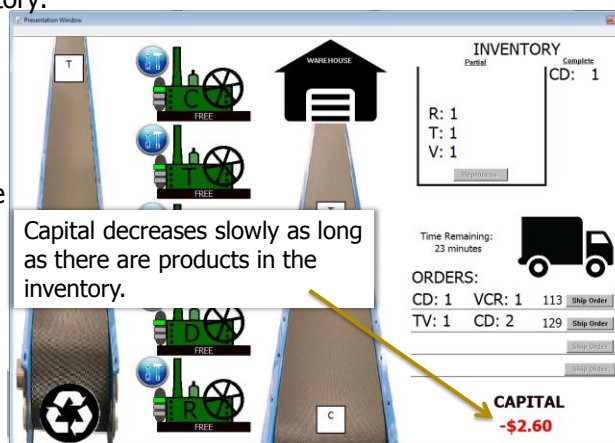
- You must use multiple machines on the same box to produce finished products.
- Machines can only process one box at a time.
- The order in which elements are added to a product is irrelevant.

Each machine has a status indicator that describes its state. If the status is "FREE," a new box can be dropped in the machine.



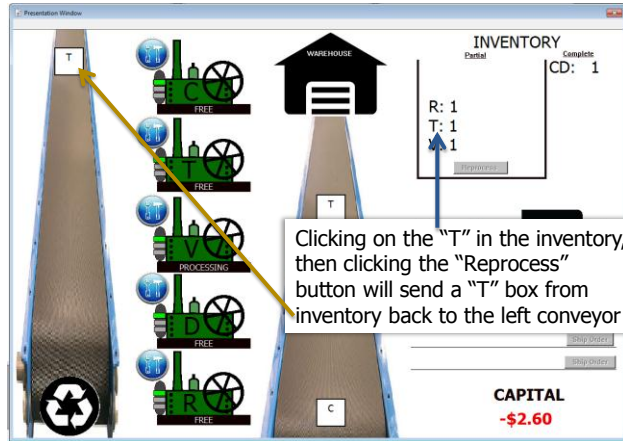
## Inventory

- When boxes are produced, they begin moving up the right conveyor to the Warehouse. Once in the Warehouse, they become part of the inventory.
- In order to ship products, they must be in the inventory.
- Storing products in the Warehouse is not free, however. There is a small charge associated with keeping products in inventory.



## Reprocessing and Recycling

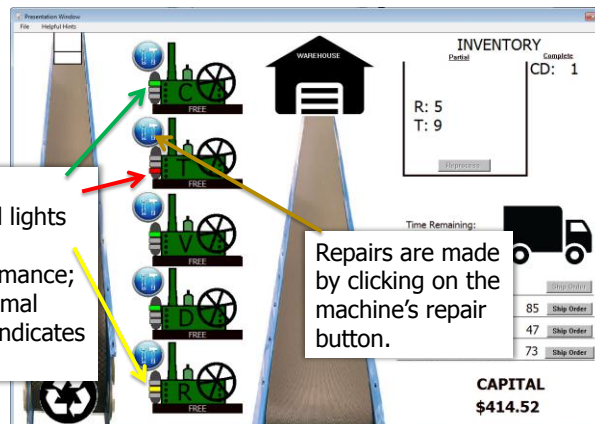
- Products in the inventory can be "reprocessed" by clicking on an item in the inventory and pressing the "Reprocess" button.
- Reprocessed boxes will show up on the left conveyor and can be dropped into machines for further processing.
- Alternatively, if the box is no longer desired, simply let it move to the bottom of the left conveyor and it will be "Recycled" or turned into an empty box again.



## Machine Maintenance

- The performance of each of the 5 machines will degrade over time if they are not properly maintained. Degraded performance means the boxes will take longer for a machine to produce.
- Performing repairs makes a machine unavailable for a short time, but restores it to optimal performance.

Maintenance needs are indicated by the colored lights on the machines. Green indicates optimal performance; Yellow indicates suboptimal performance; and Red indicates very poor performance.



## Thank You and Good Luck

- Click any key to enter the assessment

NPRST



## **Distribution List**

AIR UNIVERSITY LIBRARY  
ARMY RESEARCH INSTITUTE LIBRARY  
ARMY WAR COLLEGE LIBRARY  
CENTER FOR NAVAL ANALYSES LIBRARY  
HUMAN RESOURCES DIRECTORATE TECHNICAL LIBRARY  
JOINT FORCES STAFF COLLEGE LIBRARY  
MARINE CORPS UNIVERSITY LIBRARIES  
MARINE CORPS COMBAT DEVELOPMENT COMMAND, TRAINING AND  
EDUCATION COMMAND (TECOM)  
MARINE CORPS COMBAT DEVELOPMENT COMMAND, OPERATIONS ANALYSIS  
DIVISION (OAD)  
NATIONAL DEFENSE UNIVERSITY LIBRARY  
NAVAL HEALTH RESEARCH CENTER  
NAVAL POSTGRADUATE SCHOOL DUDLEY KNOX LIBRARY  
NAVAL RESEARCH LABORATORY RUTH HOOKER RESEARCH LIBRARY  
NAVAL WAR COLLEGE LIBRARY  
NAVY PERSONNEL RESEARCH, STUDIES, AND TECHNOLOGY SPISHOCK  
LIBRARY  
OFFICE OF NAVAL RESEARCH  
PENTAGON LIBRARY  
USAF ACADEMY LIBRARY  
US COAST GUARD ACADEMY LIBRARY  
US MERCHANT MARINE ACADEMY BLAND LIBRARY  
US MILITARY ACADEMY AT WEST POINT LIBRARY  
US NAVAL ACADEMY NIMITZ LIBRARY